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Evaluation # 200421-I (Replaces 200062-I)

**Safety & Buildings Division**
**201 West Washington Avenue**
**P.O. Box 2658**
**Madison, WI 53701-2658**

# Wisconsin Building Products Evaluation

| | |
|---|---|
| Material | REDDI-FORM<br>Insulated Concrete Form Wall System |
| Manufacturer | REDDI-FORM Systems, LLC<br>P O Box 249<br>Cascade, WI 53011 |

## SCOPE OF EVALUATION

**GENERAL:** This report evaluates the use of the REDDI-FORM Insulated Concrete Form wall system, manufactured by REDDI-FORM, LLC, evaluated as permanent form work and insulation system for reinforced lintels, exterior walls, and foundation walls. The REDDI-FORM Insulated Concrete Form wall system was evaluated for safety requirements of the foam plastic and structural requirements for the codes listed below.

The **Comm** code requirements below in accordance with the current **Wisconsin Uniform Dwelling Code for 1 & 2 family dwellings:**

- **Foam Plastic:** The REDDI-FORM Insulated Concrete Form wall system was evaluated in accordance with the fire safety requirements of **s. Comm 21.11**.
- **Structural:** The REDDI-FORM Insulated Concrete Form wall system was evaluated in accordance with the structural requirements of **ss. Comm 21.02,** and **21.02(3)(c)**.

The **IBC** requirements below in accordance with the **Wisconsin Amended ICC Code:**

- **Foam Plastic:** The REDDI-FORM Insulated Concrete Form wall system was evaluated in accordance with the fire safety requirements **ss. IBC 2603.1**, **2603.2**, and **2603.3**.
- **Structural:** The REDDI-FORM Insulated Concrete Form wall system was evaluated in accordance with the requirements of **IBC Chapter 16**.
- **Fire Endurance:** The REDDI-FORM Insulated Concrete Form wall system was evaluated in accordance with the requirements of **ss. IBC 2603.4**, **2603.5.1**, and **2603.5.2**.

**Note: Structural calculations shall be submitted (job-to-job basis) in accordance with IBC Chapter 16 for Live, Ground Snow, Roof, Wind, and Seismic Loads.**

## DESCRIPTION AND USE

**General**: REDDI-FORM insulated concrete form is manufactured using 100% modified expanded polystyrene from one of the following manufacturers: Nova Chemicals, BASF, or Huntsman Chemical.

REDDI-FORM, LLC insulated concrete forms are manufactured in two different sizes of block. One is 9-5/8" x 12" x 48". The second size is 12" x 12" x 48", which gives the same options as the smaller block but, gives an 8" core of reinforced concrete instead of a 6" core.

There are five vertical cores and the form comes in four basic shapes; a *Standard* form, a *Cornerform,* a *Closed End* form, and a *Pilaster* form. All forms are reversible side to side and top to bottom and interlock without regard to direction, therefore, the corner form can be used for right or left hand corners. The corner form becomes a tee form by cutting a core depression into the closed side of the form. The design of the interlocking teeth assures that the vertical cores align whether running in a straight line or at ninety-degree angles. Lines on the forms between cores indicate cutting locations.

Concrete: Standard applications use a minimum 3,000 lb. pea gravel pump mix, poured at a slump of 4" to 6". Concrete of higher strength may also be used. The concrete can be poured from a truck, by hand, or bucket. A concrete pump utilizing a 2" to 2 1/2" hose is recommended. It is a requirement to use a maximum gravel size of less than 1/2" for 6" cores and 1" for 8" cores. The concrete shall comply with **s. Comm 21.02(3)(b)** and **s. IBC 1903.1**.

**Reinforcement:** All steel reinforcement shall be in accordance with **s. IBC 1903.5**.

Each pallet of REDDI-FORM forms shall bear a label with the manufacturer's name, and the quality control inspection agency.

## TESTS AND RESULTS

The tests and results listed below cover both the current **IBC** requirements:

The REDDI-FORM insulated concrete forms produced by REDDI-FORM, LLC, have been subject to and complied with the following testing:

- Water Absorption of REDDI-FORM insulated concrete form, Expanded Polystyrene material in accordance with **ASTM C272**, "Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions," Method A-24 Hour Immersion.

  **ASTM C272** Test Results:

| | Density (pcf) | | | |
|---|---|---|---|---|
| | 1.0 | 1.25 | 1.5 | 2.0 |
| Water Absorption (volume) % | 0.9 - 1.9 | 0.8 - 1.8 | 0.8 - 1.6 | 0.1 - 1.5 |

- Flexural Strength Properties of REDDI-FORM insulated concrete form, expanded polystyrene material was conducted in accordance with **ASTM C203**, "Standard Test Method for Breaking Load Flexural Properties of Block-Type Thermal Insulation", Method I, Procedure A.

  **ASTM C203** Test Results:

| | Density (pcf) | | | |
|---|---|---|---|---|
| | 1.0 | 1.25 | 1.5 | 2.0 |
| Flexural Strength (psi) | 21-39 | 30-49 | 39-59 | 57-79 |

- Compressive Properties of REDDI-FORM insulated concrete form, Expanded Polystyrene material was conducted in accordance with **ASTM D1621**, "Standard Test Method for Compressive Properties of Rigid Cellular Plastics".

  **ASTM D1621** Test Results:

| | Density (pcf) | | | |
|---|---|---|---|---|
| | 1.0 | 1.25 | 1.5 | 2.0 |
| Compressive Strength at 10% Deformation (psi) | 9-13 | 14-19 | 19-24 | 31-36 |

- Dimensions and Density Properties of REDDI-FORM insulated concrete form, Expanded Polystyrene material in accordance with **ASTM C303**, "Standard Test Method for Density of Preformed Block-Type Thermal Insulation", (Section 11.2 of **ASTM C578**).

  **ASTM C303** Test Results: The minimum density for **Type I** is 0.90 pcf. The average density was 1.011 pcf.

- Surface Burning Characteristics of REDDI-FORM Insulated Concrete Form Building System assembly consists of a nominal 9-5/8" x 12" x 48" or, 12" x 12" x 48", EPS block with plastic fastening strips (polypropylene connectors), in accordance with **ASTM E84**, "Standard Test Method for Surface Burning Characteristics of Building Materials".

**ASTM E84** Test Results:

| **Foam Plastic Mfg.** | **Density Maximum Thickness** | | | | |
|---|---|---|---|---|---|
| | | **1.0 pcf 6"** | **1.25 pcf 6"** | **1.5 pcf 5"** | **2.0 pcf 5"** |
| **BASF Types**: BF-020, -122, -134, -222, -229, -322, -326, -327, -329, -422; **Types**: BFL-020, -122, -134, -222, -322, -327, -422; and **Types**: F214, -F214L, F314, F314L, and F414 | **Flame Spread** | 15 | 5 | 10 | 5 |
| | **Smoke Development** | 125 | 190 | 300 | 250 |
| | | **1.0 pcf 1" - 2"** | **1.0 pcf 4"** | **1.0 pcf 5"** | **1.0 pcf 6"** |
| **NOVA Types**: M-77 (A, A-HD, A-LV, A-NL, B, B-HD, B-HDS, B-LK, B-LV, B-NL, C, C-HD, C-NL) **Type**: M-97 | **Flame Spread** | 5 | 5 | 5 | 5 |
| | **Smoke Development** | 50-90 | 50-90 | 55-175 | 55-175 |
| | | **1.5 pcf 1" - 3"** | **1.5 pcf 4"** | **1.5 pcf 5"** | **1.5 pcf 6"** |
| **NOVA Types**: M-77 (A, A-HD, A-LV, A-NL, B, B-HD, B-HDS, B-LK, B-LV, B-NL, C, C-HD, C-NL) **Type**: M-97 | **Flame Spread** | 5 | 5 | 5 | 5 |
| | **Smoke Development** | 20 - 40-65 | 40-65 | 40-180 | 40-180 |
| | | **2.0 pcf 1" - 2"** | **2.0 pcf 4"** | **1.0 pcf 5"** | **2.0 pcf 6"** |
| **NOVA Types**: M-77 (A, A-HD, A-LV, A-NL, B, B-HD, B-HDS, B-LK, B-LV, B-NL, C, C-HD, C-NL) **Type**: M-97 | **Flame Spread** | 5 | 10 | 10 | 10 |
| | **Smoke Development** | 75 - 115 | 115-170 | 115-70 | 115-170 |
| | | **1.0 pcf 1" - 1 5/8"** | **1.0 pcf 2"** | **1.0 pcf 4"** | **1.0 pcf 5"** |
| **NOVA**: **DYLITE** 33M(A, A-HD, A-HL, B, B-HD, B-HDS, B-NL, C), M033, MF33 **DYLITE** 33M(A, B, B-K, C) | **Flame Spread** | 5 | 5 | 5 | 5 |
| | **Smoke Development** | 50 - 15-85 | 40 | 20 | 145 |
| | | _____ | _____ | **1.25 pcf 4"** | **1.25 pcf 5"** |
| **NOVA**: **DYLITE** 33M(A, A-HD, A-HL, B, B-HD, B-HDS, B-NL, C), M033, MF33 **DYLITE** 33M(A, B, B-K, C) | **Flame Spread** | _____ | _____ | 5 | 5 |
| | **Smoke Development** | ---------- | ---------- | 60-180 | 60-300 |
| | | **1.5 pcf 1"** | **1.5 pcf 1 5/8"** | --------- | **1.5 pcf 6"** |
| **NOVA**: **DYLITE** 33M(A, A-HD, A-HL, B, B-HD, B-HDS, B-NL, C), M033, MF33 **DYLITE** 33M(A, B, B-K, C) | **Flame Spread** | 5 | 5 | --------- | 5 |
| | **Smoke Development** | 15-5- | 15-40 | --------- | 165-200 |

**ASTM E84** Test Results continued:

| Foam Plastic Mfg. | Density Maximum Thickness | | | | |
|---|---|---|---|---|---|
| | | 2.0 pcf 1" | ——— | 2.0 pcf 4" | 2.0 pcf 5" |
| **NOVA**: **DYLITE** 33M(A, A-HD, A-HL, B, B-HD, B-HDS, B-NL, C), M033, MF33<br>**DYLITE** 33M(A, B, B-K, C) | **Flame Spread** | 5 | ---------- | 5 | 5 |
| | **Smoke Development** | 10 | ---------- | 15-160 | 10 |

- Thermal Properties of REDDI-FORM expanded polystyrene material (Nova Chemicals, and BASF), in accordance with **ASTM C518**, "Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus".

  **ASTM C518 Heat Flow Meter** Test Results:

| | NOVA Chemicals | BASF | | | |
|---|---|---|---|---|---|
| Average Density, lbs/ft$^{-3}$ | | 1.0 | 1.25 | 1.5 | 2.0 |
| Average Thermal Resistance, h ft$^2$ °F/Btu | | 4.5 | 4.6 | 4.5 | 4.7 |
| Average Thermal Conductivity, Btu in/h ft$^2$ °F | | .249 | .235 | .232 | .225 |

- Water Vapor Transmission Properties of REDDI-FORM insulated concrete form, expanded polystyrene material in accordance with **ASTM E96**, "Standard Test Methods for Water Vapor Transmission of Materials".

  **ASTM E96** Test Results: **Type I** maximum permeability per **ASTM** Standard **C578** is 5.0 perrms. With an average permeance value of 4.77.

- Dimensional Stability Properties of REDDI-FORM insulated concrete form, expanded polystyrene material was conducted in accordance with **ASTM D2126**, "Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging".

  **ASTM D2126** Test Results:

| | Procedure 158º F and RH 50% | Procedure -40º F and ambient RH |
|---|---|---|
| Average change in length (%) | -0.08 | 0.08 |
| Average change in width (%) | -0.09 | 0.02 |
| Average Change in Thickness (%) | -0.27 | -0.30 |
| Density of Sample (pcf) | 1.028 | 1.028 |

- Guarded Hot Box testing in accordance with **ASTM C236**, "Standard Test Method for Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box". The wall system submitted had a tested U-value of .055 with an overall R-value of 18.27. These values are for the polystyrene/concrete wall system only. Testing was performed by Sparrell Engineering Research Corporation, P.O. Box 130, Bristol Road, Damariscotta, Maine 04543.

Testing on the foam products were conducted by the following third-party testing laboratories:
1. NOVA Chemicals, 400 Frankfort Rd., Monaca, PA 15061-2298;
2. RADCO, Resources, Applications, Designs and Controls, Inc., Listing and Testing Division, 3220 E. 59th St., Long Beach, CA 90805, report number RAD-2582;
3. DYNATECH, and as noted above.

The above test data is on file with the department.

**LIMITATIONS OF APPROVAL**

The **Comm** limitations below are in accordance with the current **Wisconsin Uniform Dwelling Code, for 1 & 2 family dwellings:**

- **Foam Plastic:** The REDDI-FORM ICF wall system is approved for use with a thermal barrier to separate the blocks from interior spaces in accordance with **s. Comm 21.11(1)**. Where a 1-inch thickness of masonry does not separate the polystyrene blocks from the building interior, including at the top of the wall, a thermal barrier, which has a finish rating of at least 15 minutes, shall be provided.

1. REDDI-FORM form blocks are approved for use in combustible non-rated construction in accordance with **s. Comm 21.11**. In one- or two-family dwellings, thermal barriers shall be provided to separate the forms from the occupied space of the dwellings per **s. Comm 21.11**.
2. The exterior face of the blocks shall be finished with an approved weather covering and must be protected from ultraviolet light.

- **Structural:** The REDDI-FORM form blocks are approved as structural building elements.

1. The units are approved for use as concrete forms for basement walls and exterior walls when the resulting concrete core thickness satisfies **Table 21.18-A** for one- or two-family dwellings, or when structural calculations for the product are submitted for review.
2. Walls shall be anchored to all floors and roofs. Walls shall be interconnected at corners by embedding and lapping the reinforcement.
3. Structures are **limited** to two stories in height.
4. The forms are approved for use as concrete forms for basement walls, exterior walls and retaining walls when structural calculations are submitted to the department by a Wisconsin registered professional engineer or architect.
5. Below grade walls shall be damp-proofed when required by the local building department.
6. Damp-proofing and water-proofing materials shall be approved by REDDI-FORM and the local building official, and shall be free of solvents that will adversely affect the EPS foam.

**NOTE:** The REDDI-FORM ICF wall system was **not** evaluated for compliance with the thermal requirements of **Subchapter VI, ss. Comm 22.20**, **22.21**, **22.23**, **22.25**, **22.27**, **22.28**, and **22.31** of the current **Wisconsin Uniform Dwelling Code, for 1 & 2 family dwellings**.

The **IBC** limitations below are in accordance with the current **Wisconsin Amended ICC Code:**

- **Foam Plastic:** The REDDI-FORM wall system is approved for use with a thermal barrier to separate the blocks from interior spaces in accordance with **s. IBC 2603.4.**

1. In accordance with **s. IBC 2603.4.1.6**, when REDDI-FORM is used within the attic or crawl space where entry is made only for service utilities, the foam plastic insulation shall be protected against ignition by 1-1/2" thick mineral fiber insulation, a ¼" thick wood structural panel, particleboard or hardboard, gypsum wallboard, corrosion-resistant steel or other approved material installed so that the foam plastic is not exposed.
2. The protective covering shall be consistent with the requirements for the type of construction.
3. The exterior face of the blocks shall be finished with an approved weather covering and must be protected from ultraviolet light.
4. The crawl space shall not be used for storage or air handling purposes, there are no interconnected basement areas and entry to the crawl space is only for service of utilities.

- **Structural:** Design of concrete formed by REDDI-FORM forms must comply with **IBC Chapter 19** with the following requirements:

1. The forms are approved for use as concrete forms for basement walls, exterior walls and retaining walls when structural calculations are submitted to the department by a Wisconsin registered professional engineer or architect.
2. Design calculations of walls must comply with **s. IBC 1901.2.** Use of the empirical design approach specified in **s. 2109.1 [Comm 62.2109(1)]** is prohibited.
3. Design of lintels shall comply with the applicable provisions of **IBC Chapter 16.**
4. Wall loading shall be in accordance with **IBC Chapter 16**.
5. Minimum wall reinforcement shall conform to **s. IBC 1901.2**. When the code requires that vertical and horizontal reinforcement be spaced no further apart than 18 inches or three times the wall thickness, whichever is less, the maximum concrete wall thickness along the length of the wall is permitted to be used to determine rebar spacing.
6. Walls shall be anchored to floors and roofs in accordance with **s. IBC 1604.8.2**. Walls shall be interconnected at corners by embedding and lapping reinforcement in accordance with the code.
7. Design of shear walls shall be in accordance with **ss. IBC 1901.2** and **1910**.

8. Structures are **limited** to two stories in height plus a basement.
9. Below grade walls shall be damp-proofed when required by the local building department, water-proofed in accordance with **s. IBC 1806**.
10. Damp-proofing and water-proofing materials shall be approved by REDDI-FORM and the local building official, and shall be free of solvents that will adversely affect the EPS foam.
11. Special inspection is required as noted in **s. IBC 1704**, for placement of reinforcing steel and concrete, and for concrete cylinder testing, except that special inspection is not required for foundation stem walls conforming to **Table 1805.4.2** of the **IBC**. Additionally, when the building official approves, special inspection is not required when all of the following conditions are met:

    a) Wall systems are a maximum of 8 feet high and are limited to use in single-story construction of Group R-3, or Group U Occupancies.
    b) Maximum height of a concrete pour is 48 inches. Succeeding lifts must be placed in accordance with **s. IBC 1905.10.**
    c) Installation is by properly trained installers approved by REDDI-FORM.
    d) The installation instructions indicate methods used to verify proper placement of concrete.
12. Walls constructed with REDDI-FORM insulated concrete form blocks is considered Type V Construction.

**Alternate Design:** In lieu of calculations, the structural design of reinforced concrete formed by REDDI-FORM Insulated Concrete Form wall system for residential construction is permitted to comply with the *Prescriptive Method for Insulating Concrete Forms in Residential Construction* (publication No. EB118), dated May 1998, published by the Portland Cement Association (PCA). Buildings constructed with the REDDI-FORM Insulated Concrete Form wall system and designed in accordance with the alternate design, will not exceed a height of two stories plus a basement, where the maximum unsupported wall height is 10 feet.

**NOTE:** The REDDI-FORM Insulated Concrete Form wall system was **not** evaluated for compliance with the thermal requirements of **s. Comm 63.1018**.

**Identification:** Each package bears a label specifying the name and address of the manufacturer REDDI-FORM. Additionally, product labels indicate the Wisconsin Building Product Evaluation Number (**200421-I**), and the name and logo of the quality control agency.

This approval will be valid through December 31, 2009, unless manufacturing modifications are made to the product or a re-examination is deemed necessary by the department. The product approval is applicable to projects approved under the current edition of the applicable codes. This approval may be void for project approvals made under future applicable editions. The Wisconsin Building Product Evaluation number must be provided when plans that include this product are submitted for review.

**DISCLAIMER**

The department is in no way endorsing or advertising this product. This approval addresses only the specified applications for the product and does not waive any code requirement not specified in this document.

Revision Date:
Approval Date: August 10, 2004 By: _____

Lee E. Finley, Jr.
Product & Material Review
Integrated Services Bureau

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